JP Kokai Hei 11-260871

Title of the Invention

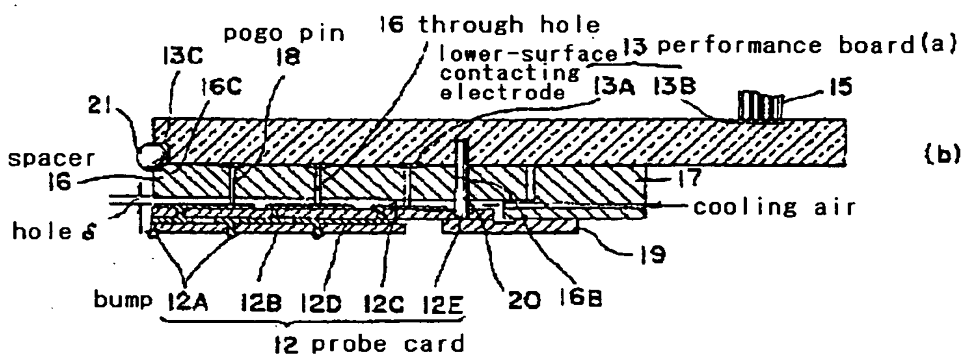
Probe Device

[Abstract]

[Problem] As shown in Fig. 8, in the case of a conventional device, a probe card 2 is electrically connected to a connection ring 3, a performance board 4 and a test head 5 in this order through pogo pins 6 at its peripheral portion with respect to every kind of probe card 2; therefore, when, upon inspection, a stylus pressure is applied to a wafer W from a probe stylus 2A, the degree of flatness of the probe card 2 is lowered due to its repulsive force. Moreover, some of pogo pins 6 are not used depending on inspections. Furthermore, a long wire is required between the probe card 2 and the test head 5, resulting in a reduction in frequency characteristics.

[Solving Means] A probe device of the present invention has an arrangement in which: lower surface contacting electrodes 13A of a performance board 13 are gathered so as to be arranged in the center portion; a spacer 16 having through holes 16A corresponding to the lower surface contacting electrodes 13A are attached to a performance board 13; a gap δ is interpolated between the probe card 12 and the spacer 16; and pogo pins 18 that elastically contact both of respective bumps 12A and lower surface contacting electrodes 13A corresponding to these are

attached to the through holes 16A of the spacer 16.



[Scope of Claims for Patent]

[Claim 1] A probe device comprising:

a mounting base capable of shifting in X, Y, Z and θ directions, on which an object to be inspected is placed;

a probe card which is placed above the mounting base, and has a plurality of contacts; and

a performance board which is electrically connected to the probe card,

the probe device bringing the contacts into contact with inspecting electrodes to carry out an electrical characteristic inspection on the object to be inspected, wherein

contacting electrodes on the probe card side of the performance board are gathered to the center portion so as to be placed in a matrix format, while a spacer having through holes having a matrix format corresponding to the contacting electrodes is attached to the performance board, and

the probe card is attached to the performance board with

a gap being interpolated between the probe card and the spacer, while elastic relaying terminals that elastically contact both of the respective contacts and the corresponding contacting electrodes are attached to through holes of the spacer.

[Claim 2] The probe card according to claim 1, wherein

the elastic relaying terminals are freely attached/detached thereto/from.

[Claim 3] The probe device according to claim 1 or 2, wherein

each of the contacting electrodes of the performance board is made greater than the outer diameter of each of the elastic relaying terminals.

[Claim 4] The probe card according to any of claims 1 to 3, wherein

a pogo pin is placed as the elastic relaying terminal.

[Claim 5] The probe card according to any of claims 1 to 4, wherein

the probe card has a substrate made of ceramics.

[Claim 6] The probe card according to any of claims 1 to 5, wherein

the contact of the probe card is gradually narrowed from the base portion toward the top end.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a probe device.

[0002]

[Prior Art]

Semiconductor manufacturing processes include an

inspection process in which, prior to a packaging process, IC chips formed on a semiconductor wafer (hereinafter, referred to simply as "wafer") are subjected to electrical characteristic inspections in the wafer state so that a screening process is preliminarily carried out so as to select good IC chips. In these inspection processes, for example, a probe device is used. In general, this probe device is provided with a loader chamber for transporting wafers, and a prober chamber which is adjacent to this, and carries out electrical characteristic inspections on each wafer transported thereto from the loader section. As shown in Fig. 8, the prober chamber is provided with a main chuck 1 capable of shifting in X, Y, Z and θ directions, on which each wafer W is placed, and a probe card 2, which is aligned face to face with the main chuck 1, is secured to the upper surface of the prober chamber. This probe card 2 is made electrically conductive to a tester head 5 connected to a tester (not shown) through a connection ring 3 and a performance board 4, and allowed to carry out electrical characteristic inspections on the wafer W based upon a signal from the tester. Here, in Fig. 8, reference numeral 6 represents each of pogo pins.

[0003]

Upon carrying out inspection processes by the use of the probe device, with a wafer W, transported from the loader chamber, being placed on the main chuck 1, the main chuck 1 is allowed to shift in X, Y, Z and θ directions so that the electrode pad

(made of, for example, aluminum) of each IC chip of the wafer W and a probe stylus 2A of the probe card 2 are positioned relative to each other, and the main chuck 1 is allowed to rise in the Z direction so that each electrode pad is made in electrically contact with the corresponding probe stylus 2A; thus, the electrical characteristic inspection is carried out on each of the IC chips.

[0004]

However, in recent years, the degree of integration of IC chips has become higher rapidly, with the result that the IC chip has come to have an ultra fine wiring structure with a narrower pitch in the electrode pad array. Accordingly, as the pitch of the probe styluses 2A in the probe card 2 becomes narrower, the number of the pogo pins 6, which provide conductivity to the test head 5, is increased abruptly, with the signal current being made extremely smaller.

[0005]

[Problems to be Solved by the Invention]

However, as shown in Fig. 8, in the case of a conventional probe device, the probe card 2 is electrically connected to the connection ring 3, the performance board 4 and the test head 5 at its peripheral portion, and pogo pins 6 are installed so as to be applied to every kind of probe cards 2 so that some of pogo pins 6 are not used depending on probe cards 2, and the number of pins to be used is increased so that, for example,

4000 or more pogo pins 6 are attached. Supposing that the pin load per one pin is 20 g, the pin load to be applied to the peripheral edge of the probe card 2 from all the pogo pins 6 tends to reach as high as 80 Kg. Moreover, when, upon inspection, a stylus pressure is imposed on the wafer W from the probe stylus 2A due to overdriving of the main chuck 1, its repulsive force causes a distortion in the center portion of the probe card 2, although the degree thereof is slight, with the result that the degree of flatness of the probe card 2 is lowered, causing adverse effects on the inspection processes. Moreover, at the time of a measuring process at a high temperature exceeding 100°C, the probe card 2 might be subjected to influences from thermal expansion and the like. Moreover, when the stylus pressure is applied to the peripheral portion of the wafer W from the probe card 2, the main chuck 1 is inclined, although the degree thereof is slight, and the resulting problem is that it becomes difficult to maintain the stylus pressure of the probe styluses 2A of the probe card 2 horizontally arranged at a constant value.

[0006]

Moreover, another problem is that, in the case of the conventional probe device, the connection ring 3 and the performance board 4 are interpolated between the probe card 2 and the test head 5 so that the wire from the test head 5 to the probe card 2 becomes longer, making the device susceptible to noise to cause degradation in the frequency characteristic.

[0007]

The present invention has been devised to solve the above-mentioned problems, and an object thereof is to provide a probe device which can reduce the pin load imposed on the probe card to properly maintain the degree of flatness of the probe card, which is less susceptible to thermal influences even at the time of an inspection process at a high temperature, and which has excellent frequency characteristics.

[0008]

[Means for Solving the Problems]

A probe device disclosed according to claim 1 of the present invention comprises: a mounting base capable of shifting in X, Y, Z and θ directions, on which an object to be inspected is placed; a probe card which is placed above the mounting base, and has a plurality of contacts; and a performance board which is electrically connected to the probe card, the probe device bringing the contacts into contact with inspecting electrodes to carry out an electrical characteristic inspection on the object to be inspected, wherein contacting electrodes on the probe card side of the performance board are gathered to the center portion so as to be placed in a matrix format, while a spacer having through holes having a matrix format corresponding to the contacting electrodes is attached to the performance board, and the probe card is attached to the performance board with a gap being interpolated between the probe card and the spacer,

while elastic relaying terminals that elastically contact both of the respective contacts and the corresponding contacting electrodes are attached to through holes of the spacer.

[0009]

In the invention according to claim 1, the probe device according to claim 2 is characterized in that the elastic relaying terminals are freely attached/detached thereto/from.

[0010]

In the invention according to claim 1 or 2, the probe device according to claim 3 is characterized in that each of the contacting electrodes of the performance board is made greater than the outer diameter of each of the elastic relaying terminals.

[0011]

In the invention according to any of claims 1 to 3, the probe device according to claim 4 is characterized in that a pogo pin is placed as the elastic relaying terminal.

[0012]

In the invention according to any of claims 1 to 4, the probe device according to claim 5 is characterized in that the probe card has a substrate made of ceramics.

[0013]

In the invention according to any of claims 1 to 5, the probe device according to claim 6 is characterized in that the contact of the probe card is gradually narrowed from the base portion toward the top end.

[0014]

[Embodiment of the Present Invention]

Referring to Figs. 1 to 7, the following description will discuss an embodiment of the present invention. For example, as shown in Fig. 7, a probe device 10 of the present invention is provided with a main chuck 11, placed in a prober chamber, which is capable of shifting X, Y, Z and θ directions, a probe card 12 having a rectangular shape, placed above the main chuck 11, and a performance board 13, made of a printed circuit board, which is connected to this probe card 12, and the probe card 12 transmits and receives inspecting signals to and from the test head 14 through the performance board 13 so that an electrical characteristic inspecting process is carried out on a wafer W which is an object to be inspected.

[0015]

Here, the probe card 12 and the performance board 13 of the present embodiment have arrangements, for example, shown in Figs. 1 to 4. In other words, as shown in Fig. 1, the probe card 12 is provided with a plurality of contacts (for example, bumps) 12A, a substrate 12B, made from ceramics (for example, quartz), which has these bumps 12A on its lower surface, and has a small thermal expansion rate with a superior heat resisting property, a plurality of contacting electrodes 12C formed on the upper surface of this substrate 12B made from ceramics in a matrix format, and wiring patterns 12D of a plurality of layers

(only one layer is shown in Fig. 1) which are formed over a plurality of upper to lower steps, and connect these contacting electrodes 12C and the bumps 12A. Moreover, the performance board 13 is provided with a plurality of lower-surface contacting electrodes 13A which are gathered to the center portion of the lower surface, and formed in a matrix format, upper-surface contacting electrodes 13B which are aligned in a plurality of rows in a ring shape on the peripheral edge on the upper surface thereof, and a wiring pattern (not shown) that electrically connects both of these electrodes 13A and 13B.

[0016]

A spacer 16 having a rectangular shape, which has a size slightly greater than the probe card 12, is secured to the lower surface of the above-mentioned performance board 13 through a first attaching member 17. As shown in Figs. 1 and 2, a plurality of through holes 16A, used for attaching pogo pins 18, are placed on the entire surface of the spacer 16 in a matrix format, and the same number of these through holes 16A are formed in association with the lower-surface contacting electrodes 13A of the performance board 13. These through holes 16A are arranged to be respectively positioned right below the lower-surface contacting electrodes 13A with the spacer 16 being secured to the performance board 13. Further, the probe card 12 and the performance board 13 are connected so as to be electrically conductive to each other through the pogo pines 18 attached to

the through holes 16A.

[0017]

Here, since the above-mentioned performance board 13 is arranged so as to be applicable to every kind of probe cards 12, the number of the lower-surface contacting electrodes 13A is set to be the same as or more than the number of the contacting electrodes 12C of each kind of the probe cards 12. Therefore, depending on the kinds of probe cards 12, all the lower-surface contacting electrodes 13A are sometimes used, and in other cases, one group of the lower-surface contacting electrodes 13A are not used. For this reason, the pogo pins 18 are freely detachably attached thereto so that, when there are some under-surface connecting electrodes 13A which are not used, the corresponding pogo pins 18 are not attached to the through holes 16A corresponding to such lower-surface connecting electrodes 13A, with the pogo pins 18 being attached to only the through holes 16A corresponding to the lower-surface contacting electrodes 13A to be used. Moreover, the outer diameter (for example, 700 to 800 μm) of the lower-surface contacting electrodes 13A is made greater than the outer diameter (for example, 20 to 30 μm) of the pogo pins 18 so that it becomes possible to easily carry out positioning processes of the pogo pins 18 on the performance board 13.

[0018]

Moreover, as shown in Fig. 1, a second attaching member

19 which is used upon attaching the prove card 12 to the performance board 13 is attached to the lower surface of the first attaching member 17. Thus, a gap δ is formed between the probe card 12 attached to the performance board 13 through the second attaching member 19 and the spacer 16 so that the pogo pins 18 attached to the spacer 16 are allowed to elastically contact both of the contacting electrodes 12C of the prove card 12 and the lower-surface contacting electrodes 13A of the performance board 13 to make the two members 12, 13 electrically conductive to each other.

[0019]

Moreover, as shown in Fig. 1, positioning pins 20, which are used for positioning the contacting electrodes 12C of the probe card 12 and the through holes 16A of the spacer 16 with respect to the performance board 13, are attached to four places on the lower surface of the above-mentioned performance board 13. These positioning pins 20 are allowed to extend downward from the lower surface of the performance board 13 and to penetrate respective positioning holes 12E, 16B formed in four corners of the probe card 12 and the spacer 16 so as to contact the second attaching member 19. Therefore, when the probe card 12 and the spacer 16 are respectively attached to the performance board 13 based upon the positioning pins 20, the pogo pins 18, respectively attached to the through holes 16A, are allowed to elastically contact both of the contacting electrodes 12C of

the probe card 12 and the lower-surface contacting electrodes 13A of the performance board 13 so that, as described above, the gap δ is formed between the probe card 12 and the spacer 16. Here, recessed sections 13C, 16C are respectively formed in the center of the lower surface of the performance board 13 and the center of the upper surface of the spacer 16, and a ball 21 is interpolated between these recessed sections 13C and 16C so that the center of the performance board 13 and the center of the spacer 16 are made coincident with each other through the ball 21.

[0020]

Here, the gap δ is formed between the probe card 12 and the spacer 16 as described above; therefore, when, upon inspection, the main chuck 11 is overdriven, the probe card 12 is allowed to rise along the positioning pins 20, while resisting the elastic force of the pogo pins 18, so that the positioning pins 20 are also allowed to function as hoisting guides.

[0021]

Moreover, for example, a vent hole 17A that allows the gap δ to communicate with the outside is formed in the first attaching member 17, and a gas pipe (not shown) for supplying a cooling gas such as air is connected to this vent hole 17A. Thus, at the time of a high-temperature inspection process, cooling air is supplied to the gap δ through the gas pipe so as to cool the probe card 12.

[0022]

Moreover, the bumps 12A on the above-mentioned probe card 12 are formed in a manner, for example, as shown in Figs. 3(a) and 3(b) as well as Fig. 4. As shown in the respective Figures, each bump 12A is gradually narrowed from the base end portion toward the top end to have a trapezoidal pyramid shape, with a flat face having a virtually square shape formed on the top thereof. As shown in Fig. 4, this bump 12A is constituted by a core unit 12F formed into a trapezoidal pyramid shape by using a material having a hardness higher than the electrode pad, for example, an ore such as diamond, sapphire and quartz and a conductive film 12G which is coated with metal having a good conductivity such as gold, rhodium or an alloy of these, and covers the outer surface thereof. Further, the base end portion of the conductive film 12G is connected to the wiring pattern 12D so as to be made conductive to the electrode pads through the conductive film 12G. As shown in Fig. 3(a), the bump 12A is formed so as to have a height H of, for example, 120 to 250 μm from the wiring pattern 12D, and the side length L of the flat face of its top is set to, for example, 10 to 15 μm. In particular, when the side length of the flat face is 30 μm or more, the bump 12A is not allowed to sufficiently cut into the electrode pad, failing to maintain sufficient contact resistance between the peripheral face of the bump 12A and the electrode pad; in contrast, when it exceeds 40 μm, it might become difficult

to make the bump cut in the electrode pad. Moreover, in the case when the side length of the flat face is not more than 8 μm, although the bump 12A is allowed to cut in the electrode pad, it becomes difficult to sufficiently maintain the contact resistance between the peripheral face of the bump 12A and the electrode pad. Here, the contact of the above-mentioned probe card 12 may be prepared as a bump 12'A having a trapezoidal cone shape, shown in Figs. 6(a) and 6(b).

[0023]

The following description will discuss the operations of the device. As shown in Fig. 5, a wafer W is placed on the main chuck 11, and when, after this has been subjected to a predetermined positioning process, the main chuck 11 is overdriven, the wafer W is allowed to rise in the Z direction to be made in contact with the bump 12A of the prove card 12 so that the wafer W is further raised. Thus, the probe card 12 is raised by the wafer W while resisting the elastic force of the pogo pins 18 so that it is allowed to rise within the gap δ in accordance with the positioning pins 20 while being maintained in parallel with the surface of the wafer W. In this case, as shown in Fig. 5, with respect to the probe card 12, a stylus force is applied to the inspecting electrode pad P of the wafer W from the bump 12 so that a shearing force is exerted onto the electrode pad P from the edge of the peripheral portion of the flat face on the top of the bump 12A; thus, the edge is

allowed to cut the surface of the electrode pad P so that the bump 12A starts to cut in the electrode pad P. Thereafter, as the wafer W is raised, the electrode pad P is pushed and widened toward the peripheral portion by the peripheral face of the bump 12A, and allowed to cut in so as to reach a position indicated by a solid line in the same Figure. In this state, the flat face of the bump 12A is made in contact with an oxide film O, and insulated from the electrode pad P; however, with respect to the peripheral face thereof, the portion which has cut in the electrode pad P is completely made in closely contact with pure aluminum which is a cut face of the electrode pad P to ensure superior conduction to the electrode pad P. When an inspection process is carried out in this state, signals are transmitted and received positively between the bump 12A and the electrode pad P, thereby making it possible to carry out an inspection process with high reliability. Moreover, since the probe card 12 and the wafer W is always maintained in parallel with each other, the stylus pressure between each of the bumps 12A and each of the electrode pads P is maintained at a constant level, thereby making it possible to carry out an inspection process with higher reliability.

[0024]

As described above, in accordance with the present embodiment, lower-surface contacting electrodes 13A of the performance board 13 are gathered to the center portion so as

to be placed in a matrix format with a spacer 16 having through holes 16A with a matrix format corresponding to the respective lower-surface contacting electrodes 13A being attached to the performance board 13, as well as the probe card 12 being attached to the performance board 13 with a gap δ being interpolated between the probe card 12 and the spacer 16, and pogo pins 18 that elastically contact both of the respective contacting electrodes 12C and the corresponding lower-surface contacting electrodes 13A are attached to through holes 16A of the spacer 16; therefore, when, upon inspection, the main chuck 11 is overdriven, the prove card 12 is allowed to electrically contact the wafer W, and to rise along the positioning pins 20 in the center portion of the performance board 13 within the gap δ while resisting the elastic force of the pogo pins 18 so that the stylus pressure of all the bumps 12A is maintained at an even level with a proper degree of flatness being always held and so that the electrical connection between the probe card 12 and the performance board 13 being positively maintained by using the pogo pins 18; thus, it becomes possible to carry out a stable inspection process with high reliability, and in accordance with the present embodiment, since the connection ring is omitted, the wiring between the probe card 12 and the test head 14 can be shortened so that it becomes possible to reduce electrical loss, also to reduce noise, and consequently to carry out a superior inspection process with high frequency characteristics.

[0025]

Moreover, in accordance with the present embodiment, since the lower-surface contacting electrodes 13A of the performance board 13 are gathered to the center portion so as to be placed in a matrix format, and since the pogo pins 18 are freely detachably attached, it becomes possible to standardize the performance board 13, and consequently to use one kind of performance board 13 irrespective of the kinds of the probe card 12. Furthermore, since the outer diameter of the lower-surface contacting electrodes 13A is made greater than the outer diameter of the pogo pins 18, it is possible to positively make the pogo pins 18 in contact with the lower-surface contacting electrodes 13A even when the positioning process of the spacer 16, which is carried out with respect to the performance board 13 based upon the positioning pins 20, is executed without high precision. Since the probe card 12 is made by using ceramics, it is less susceptible to thermal influences so that even a high-temperature inspection can be carried out stably with high reliability. Moreover, since the bump 12A of the probe card 12 is gradually narrowed from the base end portion to the top so as to have a trapezoidal pyramid shape or a trapezoidal cone shape, it is possible to electrically connect the bump 12A and the electrode pad of the wafer W positively, and consequently to improve reliability of the inspection.

[0026]

Here, the present invention is not intended to be limited by the above-mentioned respective embodiments, and it will be obvious that the same may be varied in many ways; however, such variations are not to be regarded as a departure from the spirit and scope of the invention.

[0027]

[Effects of the Invention]

In accordance with the inventions according to claims 1 to 6, it becomes possible to reduce the pin load imposed on the probe card, to maintain a proper degree of flatness in the probe card, and consequently to provide a probe device which is less susceptible to thermal influences even at the time of a high-temperature inspection, and has excellent frequency characteristics.

[Brief Description of the Drawings]

Fig. 1 is an enlarged cross-sectional view which shows the relationship between a probe card and a performance board which are essential portions of one embodiment of a probe device of the present invention.

Fig. 2 is a planar view showing a spacer in Fig. 1.

Fig. 3 is a diagram which shows one portion of the probe card of Fig. 1 in an enlarged manner; (a) is a cross-sectional view thereof; and (b) is a perspective view thereof.

Fig. 4 is a cross-sectional view of (a) of Fig. 3.

Fig. 5 is a diagram which explains operations of bumps

shown in Fig. 4.

Fig. 6 is a diagram which shows bumps of another mode in the probe card; (a) is a planar view thereof; (b) is a side view thereof.

Fig. 7 is an explanatory diagram which shows the relationship among a main chuck, a probe card, a performance board and a test head of a probe device in accordance with the present invention.

Fig. 8 is an explanatory diagram which corresponds to Fig. 7, and shows a conventional probe device.

Reference Symbols

10: probe device

11: main chuck (mounting base)

12: probe card

12A: bump (contact)

13: performance board

13A: lower-surface contacting electrode

16: spacer

16A: through hole

18: pogo pin (elastic relaying terminal)

Fig. 2

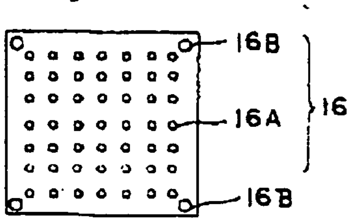


Fig. 4

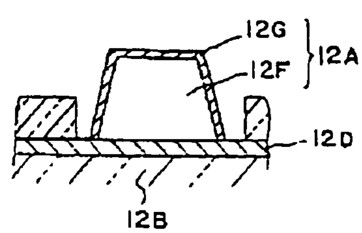


Fig. 5

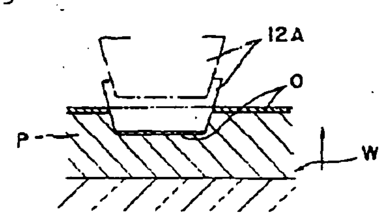


Fig. 1

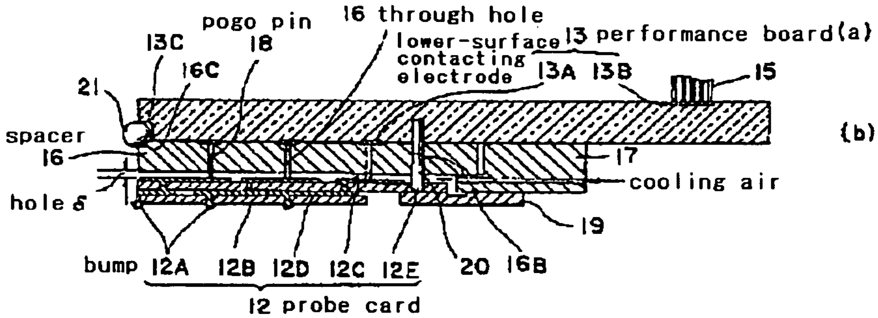


Fig. 6

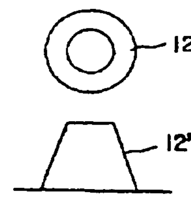


Fig. 3

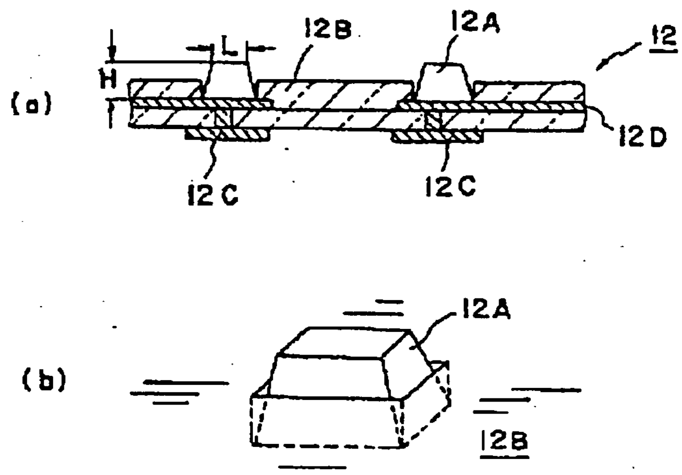


Fig. 7

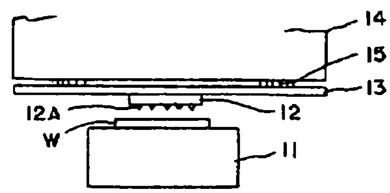
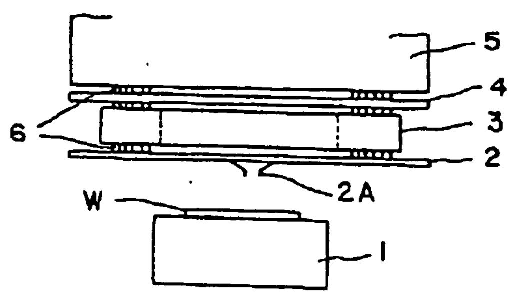


Fig. 8



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Amendment

Date of Submission

September 18, 2000

Amendment 1

Document Name of Object of Amendment

Specification

Item Name of Object of Amendment

Claims

Method of Amendment

Change

Contents of Amendment

[Scope of the Claims for Patent]

[Claim 1] A probe device comprising:

a mounting base capable of shifting in X, Y, Z and θ directions, on which an object to be inspected is placed;

a probe card which is placed above the mounting base, and has a plurality of contacts; and

a performance board <u>which is placed above the probe card and</u> which is electrically connected to the probe card,

the probe device bringing the contacts into contact with inspecting electrodes to carry out an electrical characteristic inspection on the object to be inspected, wherein

contacting electrodes on the probe card side of the performance board are gathered to the center portion so as to be placed in a matrix format, while a spacer having through holes

having a matrix format corresponding to the contacting electrodes is attached to the performance board, and

the probe card is attached to the performance board with a gap being interpolated between the probe card and the spacer, while elastic relaying terminals that elastically contact both of the contacting electrodes and contacting electrodes of the probe card corresponding to the contacting electrodes are attached to through holes of the spacer.

[Claim 2] The probe device according to claim 1, wherein

the elastic relaying terminals are freely attached/detached thereto/from.

[Claim 3] The probe device according to claim 1 or 2, wherein

each of the contacting electrodes of the performance board is made greater than the outer diameter of each of the elastic relaying terminals.

[Claim 4] The probe device according to any of claims 1 to 3, wherein

a pogo pin is placed as the elastic relaying terminal.

[Claim 5] The probe device according to any of claims 1 to 4, wherein

the probe card has a substrate made of ceramics.

[Claim 6] The probe device according to any of claims 1 to 5, wherein

the contact of the probe card is gradually narrowed from the base portion toward the top end.

[Claim 7] The probe device according to any of claims 1 to 6, wherein

the probe card is capable of ascending and descending in accordance with a positioning pin sticking out downward from the performance board.

[Claim 8] The probe device according to any of claims 1 to 7, wherein

the cooling gas is allowed to flow through the gap between the probe card and the spacer.

[Amendment 2]

[Document Name of Object of Amendment] Specification

[Item Name of Object of Amendment] Detailed Description of the Invention

[Method of Amendment] Change

[Contents of Amendment]

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a probe device.

[0002]

[Prior Art]

Semiconductor manufacturing processes include an inspection process in which, prior to a packaging process, IC chips formed on a semiconductor wafer (hereinafter, referred to simply as "wafer") are subjected to electrical characteristic

inspections in the wafer state so that a screening process is preliminarily carried out so as to select good IC chips. In these inspection processes, for example, a probe device is used. In general, this probe device is provided with a loader chamber for transporting wafers, and a prober chamber which is adjacent to this, and carries out electrical characteristic inspections on each wafer transported thereto from the loader section. As shown in Fig. 8, the prober chamber is provided with a main chuck 1 capable of shifting in X, Y, Z and θ directions, on which each wafer W is placed, and a probe card 2, which is aligned face to face with the main chuck 1, is secured to the upper surface of the prober chamber. This probe card 2 is made electrically conductive to a tester head 5 connected to a tester (not shown) through a connection ring 3 and a performance board 4, and allowed to carry out electrical characteristic inspections on the wafer W based upon a signal from the tester. Here, in Fig. 8, reference numeral 6 represents each of pogo pins.

[0003]

Upon carrying out inspection processes by the use of the probe device, with a wafer W, transported from the loader chamber, being placed on the main chuck 1, the main chuck 1 is allowed to shift in X, Y, Z and θ directions so that the electrode pad (made of, for example, aluminum) of each IC chip of the wafer W and a probe stylus 2A of the probe card 2 are positioned relative to each other, and the main chuck 1 is allowed to rise in the

Z direction so that each electrode pad is made in electrically contact with the corresponding probe stylus 2A; thus, the electrical characteristic inspection is carried out on each of the IC chips.

[0004]

However, in recent years, the degree of integration of IC chips has become higher rapidly, with the result that the IC chip has come to have an ultra fine wiring structure with a narrower pitch in the electrode pad array. Accordingly, as the pitch of the probe styluses 2A in the probe card 2 becomes narrower, the number of the pogo pins 6, which provide conductivity to the test head 5, is increased abruptly, with the signal current being made extremely smaller.

[0005]

[Problems to be Solved by the Invention]

However, as shown in Fig. 8, in the case of a conventional probe device, the probe card 2 is electrically connected to the connection ring 3, the performance board 4 and the test head 5 at its peripheral portion, and pogo pins 6 are installed so as to be applied to every kind of probe cards 2 so that some of pogo pins 6 are not used depending on probe cards 2, and the number of pins to be used is increased so that, for example, 4000 or more pogo pins 6 are attached. Supposing that the pin load per one pin is 20 g, the pin load to be applied to the peripheral edge of the probe card 2 from all the pogo pins 6 tends to reach

as high as 80 Kg. Moreover, when, upon inspection, a stylus pressure is imposed on the wafer W from the probe stylus 2A due to overdriving of the main chuck 1, its repulsive force causes a distortion in the center portion of the probe card 2, although the degree thereof is slight, with the result that the degree of flatness of the probe card 2 is lowered, causing adverse effects on the inspection processes. Moreover, at the time of a measuring process at a high temperature exceeding 100°C, the probe card 2 might be subjected to influences from thermal expansion and the like. Moreover, when the stylus pressure is applied to the peripheral portion of the wafer W from the probe card 2, the main chuck 1 is inclined, although the degree thereof is slight, and the resulting problem is that it becomes difficult to maintain the stylus pressure of the probe styluses 2A of the probe card 2 horizontally arranged at a constant value.

[0006]

Moreover, another problem is that, in the case of the conventional probe device, the connection ring 3 and the performance board 4 are interpolated between the probe card 2 and the test head 5 so that the wire from the test head 5 to the probe card 2 becomes longer, making the device susceptible to noise to cause degradation in the frequency characteristic.

[0007]

The present invention has been devised to solve the above-mentioned problems, and an object thereof is to provide

a probe device which can reduce the pin load imposed on the probe card to properly maintain the degree of flatness of the probe card, which is less susceptible to thermal influences even at the time of an inspection process at a high temperature, and which has excellent frequency characteristics.

[0008]

[Means for Solving the Problems]

A probe device disclosed according to claim 1 of the present invention comprises: a mounting base capable of shifting in X, Y, Z and θ directions, on which an object to be inspected is placed; a probe card which is placed above the mounting base, and has a plurality of contacts; and a performance board which is placed above the probe card and which is electrically connected to the probe card, the probe device bringing the contacts into contact with inspecting electrodes to carry out an electrical characteristic inspection on the object to be inspected, wherein contacting electrodes on the probe card side of the performance board are gathered to the center portion so as to be placed in a matrix format, while a spacer having through holes having a matrix format corresponding to the contacting electrodes is attached to the performance board, and the probe card is attached to the performance board with a gap being interpolated between the probe card and the spacer, while elastic relaying terminals that elastically contact both of the contacting electrodes and contacting electrodes of the probe card corresponding to the

contacting electrodes are attached to through holes of the spacer.

[0009]

In the invention according to claim 1, the probe device according to claim 2 is characterized in that the elastic relaying terminals are freely attached/detached thereto/from.

[0010]

In the invention according to claim 1 or 2, the probe device according to claim 3 is characterized in that each of the contacting electrodes of the performance board is made greater than the outer diameter of each of the elastic relaying terminals.

[0011]

In the invention according to any of claims 1 to 3, the probe device according to claim 4 is characterized in that a pogo pin is placed as the elastic relaying terminal.

[0012]

In the invention according to any of claims 1 to 4, the probe device according to claim 5 is characterized in that the probe card has a substrate made of ceramics.

[0013]

In the invention according to any of claims 1 to 5, the probe device according to claim 6 is characterized in that the contact of the probe card is gradually narrowed from the base portion toward the top end.

[0014]

In the invention according to any of claims 1 to 6, the probe device according to claim 7 is characterized in that the probe card is capable of ascending and descending in accordance with a positioning pin sticking out downward from the performance board.

[0015]

In the invention according to any of claims 1 to 7, the probe device according to claim 8 is characterized in that a cooling gas is allowed to flow through the gap between the probe card and the spacer.

[0016]

[Embodiment of the Present Invention]

Referring to Figs. 1 to 7, the following description will discuss an embodiment of the present invention. For example, as shown in Fig. 7, a probe device 10 of the present invention is provided with a main chuck 11, placed in a prober chamber, which is capable of shifting X, Y, Z and θ directions, a probe card 12 having a rectangular shape, placed above the main chuck 11, and a performance board 13, made of a printed circuit board, which is connected to this probe card 12, and the probe card 12 transmits and receives inspecting signals to and from the test head 14 through the performance board 13 so that an electrical characteristic inspecting process is carried out on a wafer W which is an object to be inspected.

[0017]

Here, the probe card 12 and the performance board 13 of the present embodiment have arrangements, for example, shown in Figs. 1 to 4. In other words, as shown in Fig. 1, the probe card 12 is provided with a plurality of contacts (for example, bumps) 12A, a substrate 12B, made from ceramics (for example, quartz), which has these bumps 12A on its lower surface, and has a small thermal expansion rate with a superior heat resisting property, a plurality of contacting electrodes 12C formed on the upper surface of this substrate 12B made from ceramics in a matrix format, and wiring patterns 12D of a plurality of layers (only one layer is shown in Fig. 1) which are formed over a plurality of upper to lower steps, and connect these contacting electrodes 12C and the bumps 12A. Moreover, the performance board 13 is provided with a plurality of lower-surface contacting electrodes 13A which are gathered to the center portion of the lower surface, and formed in a matrix format, upper-surface contacting electrodes 13B which are aligned in a plurality of rows in a ring shape on the peripheral edge on the upper surface thereof, and a wiring pattern (not shown) that electrically connects both of these electrodes 13A and 13B.

[0018]

A spacer 16 having a rectangular shape, which has a size slightly greater than the probe card 12, is secured to the lower surface of the above-mentioned performance board 13 through a first attaching member 17. As shown in Figs. 1 and 2, a plurality

of through holes 16A, used for attaching pogo pins 18, are placed on the entire surface of the spacer 16 in a matrix format, and the same number of these through holes 16A are formed in association with the lower-surface contacting electrodes 13A of the performance board 13. These through holes 16A are arranged to be respectively positioned right below the lower-surface contacting electrodes 13A with the spacer 16 being secured to the performance board 13. Further, the probe card 12 and the performance board 13 are connected so as to be electrically conductive to each other through the pogo pines 18 attached to the through holes 16A.

[0019]

Here, since the above-mentioned performance board 13 is arranged so as to be applicable to every kind of probe cards 12, the number of the lower-surface contacting electrodes 13A is set to be the same as or more than the number of the contacting electrodes 12C of each kind of the probe cards 12. Therefore, depending on the kinds of probe cards 12, all the lower-surface contacting electrodes 13A are sometimes used, and in other cases, one group of the lower-surface contacting electrodes 13A are not used. For this reason, the pogo pins 18 are freely detachably attached thereto so that, when there are some under-surface connecting electrodes 13A which are not used, the corresponding pogo pins 18 are not attached to the through holes 16A corresponding to such lower-surface connecting electrodes 13A,

with the pogo pins 18 being attached to only the through holes 16A corresponding to the lower-surface contacting electrodes 13A to be used. Moreover, the outer diameter (for example, 700 to 800 μm) of the lower-surface contacting electrodes 13A is made greater than the outer diameter (for example, 20 to 30 μm) of the pogo pins 18 so that it becomes possible to easily carry out positioning processes of the pogo pins 18 on the performance board 13.

[0020]

Moreover, as shown in Fig. 1, a second attaching member 19 which is used upon attaching the prove card 12 to the performance board 13 is attached to the lower surface of the first attaching member 17. Thus, a gap δ is formed between the probe card 12 attached to the performance board 13 through the second attaching member 19 and the spacer 16 so that the pogo pins 18 attached to the spacer 16 are allowed to elastically contact both of the contacting electrodes 12C of the prove card 12 and the lower-surface contacting electrodes 13A of the performance board 13 to make the two members 12, 13 electrically conductive to each other.

[0021]

Moreover, as shown in Fig. 1, positioning pins 20, which are used for positioning the contacting electrodes 12C of the probe card 12 and the through holes 16A of the spacer 16 with respect to the performance board 13, are attached to four places

on the lower surface of the above-mentioned performance board 13. These positioning pins 20 are allowed to extend downward from the lower surface of the performance board 13 and to penetrate respective positioning holes 12E, 16B formed in four corners of the probe card 12 and the spacer 16 so as to contact the second attaching member 19. Therefore, when the probe card 12 and the spacer 16 are respectively attached to the performance board 13 based upon the positioning pins 20, the pogo pins 18, respectively attached to the through holes 16A, are allowed to elastically contact both of the contacting electrodes 12C of the probe card 12 and the lower-surface contacting electrodes 13A of the performance board 13 so that, as described above, the gap δ is formed between the probe card 12 and the spacer 16. Here, recessed sections 13C, 16C are respectively formed in the center of the lower surface of the performance board 13 and the center of the upper surface of the spacer 16, and a ball 21 is interpolated between these recessed sections 13C and 16C so that the center of the performance board 13 and the center of the spacer 16 are made coincident with each other through the ball 21.

[0022]

Here, the gap δ is formed between the probe card 12 and the spacer 16 as described above; therefore, when, upon inspection, the main chuck 11 is overdriven, the probe card 12 is allowed to rise along the positioning pins 20, while resisting

the elastic force of the pogo pins 18, so that the positioning pins 20 are also allowed to function as hoisting guides.

[0023]

Moreover, for example, a vent hole 17A that allows the gap δ to communicate with the outside is formed in the first attaching member 17, and a gas pipe (not shown) for supplying a cooling gas such as air is connected to this vent hole 17A. Thus, at the time of a high-temperature inspection process, cooling air is supplied to the gap δ through the gas pipe so as to cool the probe card 12.

[0024]

Moreover, the bumps 12A on the above-mentioned probe card 12 are formed in a manner, for example, as shown in Figs. 3(a) and 3(b) as well as Fig. 4. As shown in the respective Figures, each bump 12A is gradually narrowed from the base end portion toward the top end to have a trapezoidal pyramid shape, with a flat face having a virtually square shape formed on the top thereof. As shown in Fig. 4, this bump 12A is constituted by a core unit 12F formed into a trapezoidal pyramid shape by using a material having a hardness higher than the electrode pad, for example, an ore such as diamond, sapphire and quartz and a conductive film 12G which is coated with metal having a good conductivity such as gold, rhodium or an alloy of these, and covers the outer surface thereof. Further, the base end portion of the conductive film 12G is connected to the wiring pattern

12D so as to be made conductive to the electrode pads through the conductive film 12G. As shown in Fig. 3(a), the bump 12A is formed so as to have a height H of, for example, 120 to 250 μm from the wiring pattern 12D, and the side length L of the flat face of its top is set to, for example, 10 to 15 μm. In particular, when the side length of the flat face is 30 μm or more, the bump 12A is not allowed to sufficiently cut into the electrode pad, failing to maintain sufficient contact resistance between the peripheral face of the bump 12A and the electrode pad; in contrast, when it exceeds 40 μm, it might become difficult to make the bump cut in the electrode pad. Moreover, in the case when the side length of the flat face is not more than 8 μm, although the bump 12A is allowed to cut in the electrode pad, it becomes difficult to sufficiently maintain the contact resistance between the peripheral face of the bump 12A and the electrode pad. Here, the contact of the above-mentioned probe card 12 may be prepared as a bump 12'A having a trapezoidal cone shape, shown in Figs. 6(a) and 6(b).

[0025]

The following description will discuss the operations of the device. As shown in Fig. 5, a wafer W is placed on the main chuck 11, and when, after this has been subjected to a predetermined positioning process, the main chuck 11 is overdriven, the wafer W is allowed to rise in the Z direction to be made in contact with the bump 12A of the prove card 12

so that the wafer W is further raised. Thus, the probe card 12 is raised by the wafer W while resisting the elastic force of the pogo pins 18 so that it is allowed to rise within the gap δ in accordance with the positioning pins 20 while being maintained in parallel with the surface of the wafer W. In this case, as shown in Fig. 5, with respect to the probe card 12, a stylus force is applied to the inspecting electrode pad P of the wafer W from the bump 12 so that a shearing force is exerted onto the electrode pad P from the edge of the peripheral portion of the flat face on the top of the bump 12A; thus, the edge is allowed to cut the surface of the electrode pad P so that the bump 12A starts to cut in the electrode pad P. Thereafter, as the wafer W is raised, the electrode pad P is pushed and widened toward the peripheral portion by the peripheral face of the bump 12A, and allowed to cut in so as to reach a position indicated by a solid line in the same Figure. In this state, the flat face of the bump 12A is made in contact with an oxide film O, and insulated from the electrode pad P; however, with respect to the peripheral face thereof, the portion which has cut in the electrode pad P is completely made in closely contact with pure aluminum which is a cut face of the electrode pad P to ensure superior conduction to the electrode pad P. When an inspection process is carried out in this state, signals are transmitted and received positively between the bump 12A and the electrode pad P, thereby making it possible to carry out an inspection

process with high reliability. Moreover, since the probe card 12 and the wafer W is always maintained in parallel with each other, the stylus pressure between each of the bumps 12A and each of the electrode pads P is maintained at a constant level, thereby making it possible to carry out an inspection process with higher reliability.

[0026]

As described above, in accordance with the present embodiment, lower-surface contacting electrodes 13A of the performance board 13 are gathered to the center portion so as to be placed in a matrix format with a spacer 16 having through holes 16A with a matrix format corresponding to the respective lower-surface contacting electrodes 13A being attached to the performance board 13, as well as the probe card 12 being attached to the performance board 13 with a gap δ being interpolated between the probe card 12 and the spacer 16, and pogo pins 18 that elastically contact both of the respective contacting electrodes 12C and the corresponding lower-surface contacting electrodes 13A are attached to through holes 16A of the spacer 16; therefore, when, upon inspection, the main chuck 11 is overdriven, the prove card 12 is allowed to electrically contact the wafer W, and to rise along the positioning pins 20 in the center portion of the performance board 13 within the gap δ while resisting the elastic force of the pogo pins 18 so that the stylus pressure of all the bumps 12A is maintained at an even level with a proper degree

of flatness being always held and so that the electrical connection between the probe card 12 and the performance board 13 being positively maintained by using the pogo pins 18; thus, it becomes possible to carry out a stable inspection process with high reliability, and in accordance with the present embodiment, since the connection ring is omitted, the wiring between the probe card 12 and the test head 14 can be shortened so that it becomes possible to reduce electrical loss, also to reduce noise, and consequently to carry out a superior inspection process with high frequency characteristics.

[0027]

Moreover, in accordance with the present embodiment, since the lower-surface contacting electrodes 13A of the performance board 13 are gathered to the center portion so as to be placed in a matrix format, and since the pogo pins 18 are freely detachably attached, it becomes possible to standardize the performance board 13, and consequently to use one kind of performance board 13 irrespective of the kinds of the probe card 12. Furthermore, since the outer diameter of the lower-surface contacting electrodes 13A is made greater than the outer diameter of the pogo pins 18, it is possible to positively make the pogo pins 18 in contact with the lower-surface contacting electrodes 13A even when the positioning process of the spacer 16, which is carried out with respect to the performance board 13 based upon the positioning pins 20, is executed without high precision.

Since the probe card 12 is made by using ceramics, it is less susceptible to thermal influences so that even a high-temperature inspection can be carried out stably with high reliability. Moreover, since the bump 12A of the probe card 12 is gradually narrowed from the base end portion to the top so as to have a trapezoidal pyramid shape or a trapezoidal cone shape, it is possible to electrically connect the bump 12A and the electrode pad of the wafer W positively, and consequently to improve reliability of the inspection.

[0028]

Here, the present invention is not intended to be limited by the above-mentioned respective embodiments, and it will be obvious that the same may be varied in many ways; however, such variations are not to be regarded as a departure from the spirit and scope of the invention.

[0029]

Effects of the Invention

In accordance with the inventions according to claims 1 to 8, it becomes possible to reduce the pin load imposed on the probe card, to maintain a proper degree of flatness in the probe card, and consequently to provide a probe device which is less susceptible to thermal influences even at the time of a high-temperature inspection, and has excellent frequency characteristics.